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DYNAMICS OF ACHIEVEMENT--A STUDY OF DIFFERENTIAL GROWTH OF ACHIEVEMENT OVER TIME.

BY- OKADA, TETSUO AND OTHERS
NATIONAL CENTER FOR EDUCATIONAL STATISTICS (DHEW)

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DESCRIPTORS- *ACADEMIC ACHIEVEMENT, *NEGRO ACHIEVEMENT, *ACHIEVEMENT TESTS, *NEGRO STUDENTS, METROPOLITAN AREAS, GRADE 6, SECONDARY GRADES, STANDARDIZED TESTS, SEQUENTIAL TEST OF EDUCATIONAL PROGRESS, SCHOOL AND COLLEGE ABILITY TEST, INTER-AMERICAN TESTS OF GENERAL ABILITY,

IN THE EDUCATIONAL OPPORTUNITY SURVEY, STANDARDIZED TESTS WERE GIVEN FOR GRADES 1, 3, 6, 9, AND 12. DATA WERE PRESENTED IN TERMS OF RACE, METROPOLITAN-NONMETROPOLITAN AREA, AND REGION. THE PURPOSES WERE TO--(1) PRESENT DATA SHOWING INCREASES IN ACHIEVEMENT, AND (2) CHARACTERIZE THE GROWTH IN ACHIEVEMENT BY RACE, METROPOLITAN-NONMETROPOLITAN AREA, AND GEOGRAPHIC LOCATIONS, TO PROVIDE A YARDSTICK OF ACHIEVEMENT FOR SPECIFIC RACES AND REGIONS. RESULTS SHOWED A LARGE DIFFERENTIAL RATE OF GROWTH OF ACHIEVEMENT AMONG RACES. NEGRO STUDENTS DO NOT ATTAIN THE SIXTH-GRADE ABILITY LEVEL UNTIL GRADE 8 FOR READING COMPREHENSION, VERBAL ABILITY, AND MATHEMATICS. FROM GRADE 6 THROUGH GRADE 12, THERE IS A GRADUALLY INCREASING GAP BETWEEN THE NEGRO AND WHITE STUDENTS FOR THE SUBJECT AREAS MENTIONED. SIMILAR LAGS IN ACHIEVEMENT ARE OBSERVED FOR OTHER DISADVANTAGED STUDENT GROUPS. TEST SCORES, NATIONAL MEANS AND TEST SCORES FOR WHITE AND NEGRO, AND GRADE-LEVEL EQUIVALENT COMPARISONS ARE GIVEN. (PH)

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DYNAMICS OF ACHIEVEMENT: A STUDY OF DIFFERENTIAL GROWTH OF ACHIEVEMENT OVER TIME

by

Tetsuo Okada
David S. Stoller
Frederic D. Weinfeld

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DYNAMICS OF ACHIEVEMENT: A STUDY OF DIFFERENTIAL GROWTH OF ACHIEVEMENT OVER TIME

INTRODUCTION

In the Educational Opportunity Survey[1/], standardized tests were given for grades 1, 3, 6, 9 and 12 and the data presented in terms of race, metropolitan-nonmetropolitan areas (SMSA-NonSMSA), and region. The purpose of this note is threefold: (1) to present data showing increases in achievement, through the grades by single years of grade for the various groups, (2) to characterize the growth in achievement by race, metropolitan-nonmetropolitan areas, and geographic locations, so as to provide a yardstick of achievement for specific races and regions, and (3) the documentation of the data originally presented in the Survey report in the form of charts and graphs. This present note is the first of a two-part series. The analysis in this note is restricted to overall averages for all races and breakouts of overall averages into White and Negro averages.

1/ James S. Coleman, et al., Equality of Educational Opportunity, (OE 38001). U.S. Department of Health, Education, and Welfare, National Center for Educational Statistics, U.S. Government Printing Office, Washington, D.C.: 1966, Catalog No. FS5. 38001, and Supplement.

SUMMARY OF RESULTS

The differential rate of growth of achievement among races is startlingly large. For example at grade 6, Negro students are already 3.0 years, 2.0 years, and 2.5 years behind the White students in Reading Comprehension, Verbal Ability, and Mathematics, respectively. By the time Negro students complete high school, they are 3.4 years, 3.8 years, and 5.5 years behind the white students in the above subject matter areas.

In terms of grade level accomplishments, Negro students do not attain the 6th grade ability level (reached by the total school population) until grade 8 for the three subject matter areas. By grade 12 Negro students are doing only 9th grade ability work for Reading Comprehension and Verbal Ability, and 7th grade work in Mathematics.

From grade 6 through grade 12, there is an ever-widening gap between the Negro and White students for each of the above subject matter areas. For Reading Comprehension, the difference between Negro and White students increase from 3.0 years at grade 6 to 3.4 years at grade 12. For Verbal Ability the gap almost doubles from 2.0 years at grade 6 to 3.8 years at grade 12. In Mathematics, this increasing lag is substantially more than double: from 2.5 years to 5.5 years.

Similar lags in growth of achievement are observed for other disadvantaged student groups.

PROCEDURE

In order to obtain growth in achievement by single years of grade, the data were plotted for gross intervals of time (available by two or three grade intervals) and the values for the years in-between were interpolated from the graphs. There were two problems to be solved in this procedure, namely, (1) comparability of test scores from grade to grade, and (2) the shape of the curves connecting the two or three year interval.

Test Score Comparability

Comparability of test scores for grades 1, 3, 6, 9 and 12 is essential in order to be able to determine, through interpolation, growth by single years of grade. Comparability in this sense refers to the ability of tests to be "interlocked" in order that a common metric may be applied to test scores from grade to grade. For example, if the same test is given to students in all grades from 1 to 12, then each of the test scores for each individual grade has been automatically "interlocked" with the test scores for the other grades. Then it would be possible to say, for example, that the test score for a particular student in grade 5, is greater than the mean test score for grade 4 but less than the score for grade 6. If different tests had been given to separate grades, then obviously test score results alone would not permit grade-by-grade comparisons.

Instead of using the same test for all grades to achieve comparability, other techniques are used for this purpose. For example, if 4th grade

students are given both 3rd grade and 4th grade tests, for which they receive mean test scores of 60 and 50, respectively, then it would be possible to infer that 3rd grade students who achieve a score of 60 on the 3rd grade test would receive a 50 on the 4th grade test. In similar fashion, test scores for the various grades are interlocked and comparability over the grades is thus established.

The following table shows the types of tests and grades for which each is "interlocked":

Grades	Verbal	Read	Math
1	IAT	STEP	STEP
3	IAT	STEP	STEP
6	(SCAT)	(STEP)	(STEP)
9	(SCAT)	(STEP)	(STEP)
12	(SCAT)	(STEP)	(STEP)

( )= Interlocked Tests

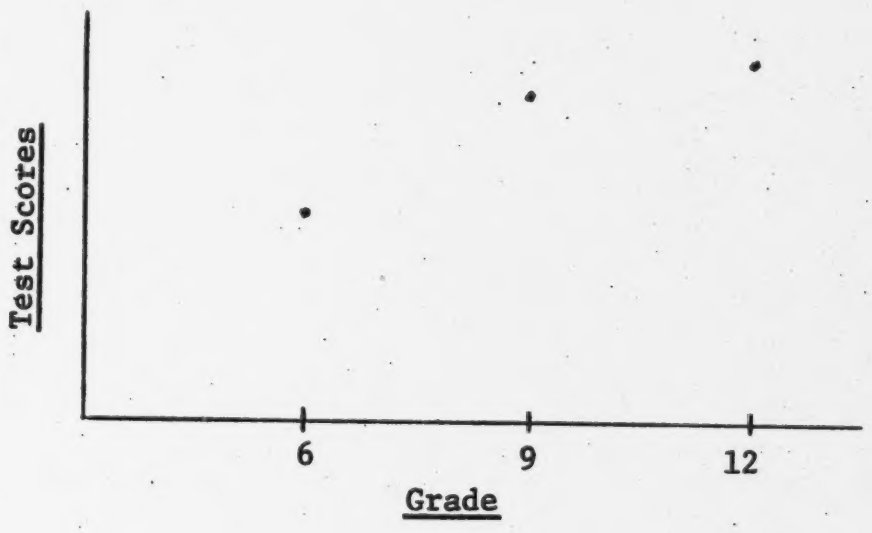
Test scores for three of the tests (Reading[2/], Verbal Ability[3/], and Mathematics[4/]) were expressed in the same units for grades 6, 9, and 12 only. Equivalent scores for the other grades, were not available and could not be used.

2/ ETS Sequential Test of Educational Progress Series (STEP).

3/ Grades 1 and 3: Inter-American Tests of General Ability (IAT)
Grades 6 through 12: Educational Testing Service (ETS) School and College Ability Test series (SCAT).

4/ STEP. (Grade 3 Step Tests not yet interlocked).

Thus, from the preceding information on interlocked tests, the following has been established: for reading, verbal ability and mathematics, score points may be plotted on a graph showing growth in achievement over grades 6, 9, 12 but not for other grades:



Justification for Linear Interpolation

In order to interpolate for the in-between grades, namely 7, 8, 10 and 11, it is necessary to determine the shape of the curve connecting any two known points. It would certainly be helpful, for example, if a simple straight line could be drawn from, say, the 6th grade achievement scores to the 9th grade scores, in order to determine achievement growth scores for grades 7 and 8. The shape of the curve, however, cannot be assumed, a priori, without empirical justification.

Analysis of New York State Data

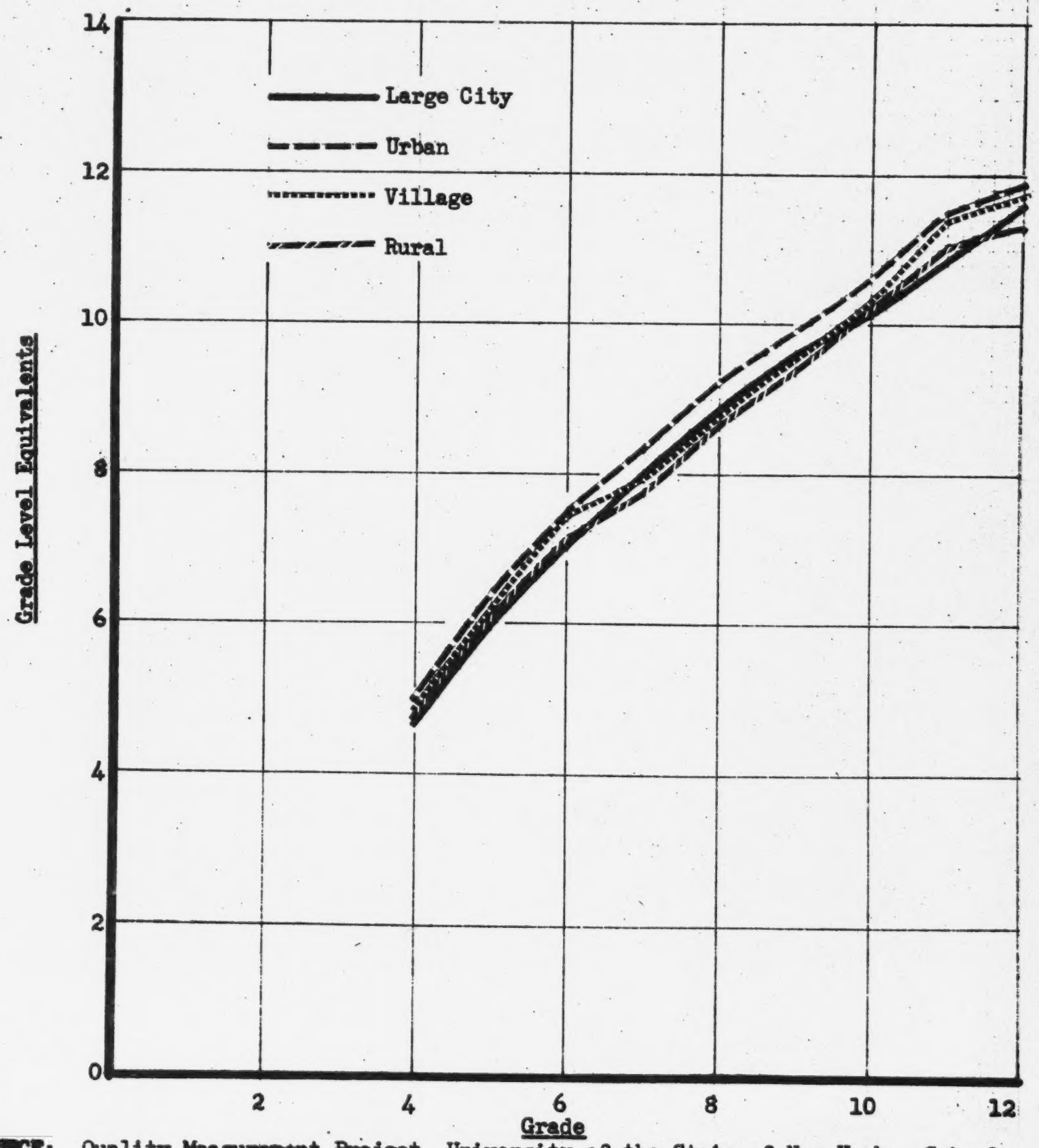
Fortunately, there are available studies of growth in achievement by single years of grade, and the results of one such study,[5/] conducted by New York State, were chosen to illuminate this problem. Further, the New York State study included information concerning size of community (large city, urban, village and rural), five socio-economic levels, and selected combinations of community size and socio-economic levels. Figures 1 - 3 show the type of graphical information given by New York State data. The Grade Level Equivalents shown on the vertical (Y) axis were based on nationwide norms developed by the Iowa Test of Basic Skills for grades 4 - 9 and the Iowa Tests of Educational Development for grades 10 - 12.

When New York State data are plotted, it can be seen that a straight line may, in most cases, be used to connect the grades from 4 through 6, 6 through 9, and 9 through 12 as illustrated. Although New York State means are above national norms, and strictly speaking, their results can only be applied to comparable states, the consistency of linearity among the various graphs gives at least some rationale for using straight line interpolation methods for EOS data.

5/ Quality Measurement Project, University of the State of New York. School Quality Workbook: Achievement Norms for New York State Schools by Type of Community and Socioeconomic Level. New York State Education Department, Division of Research: January 1963.

Figure 1

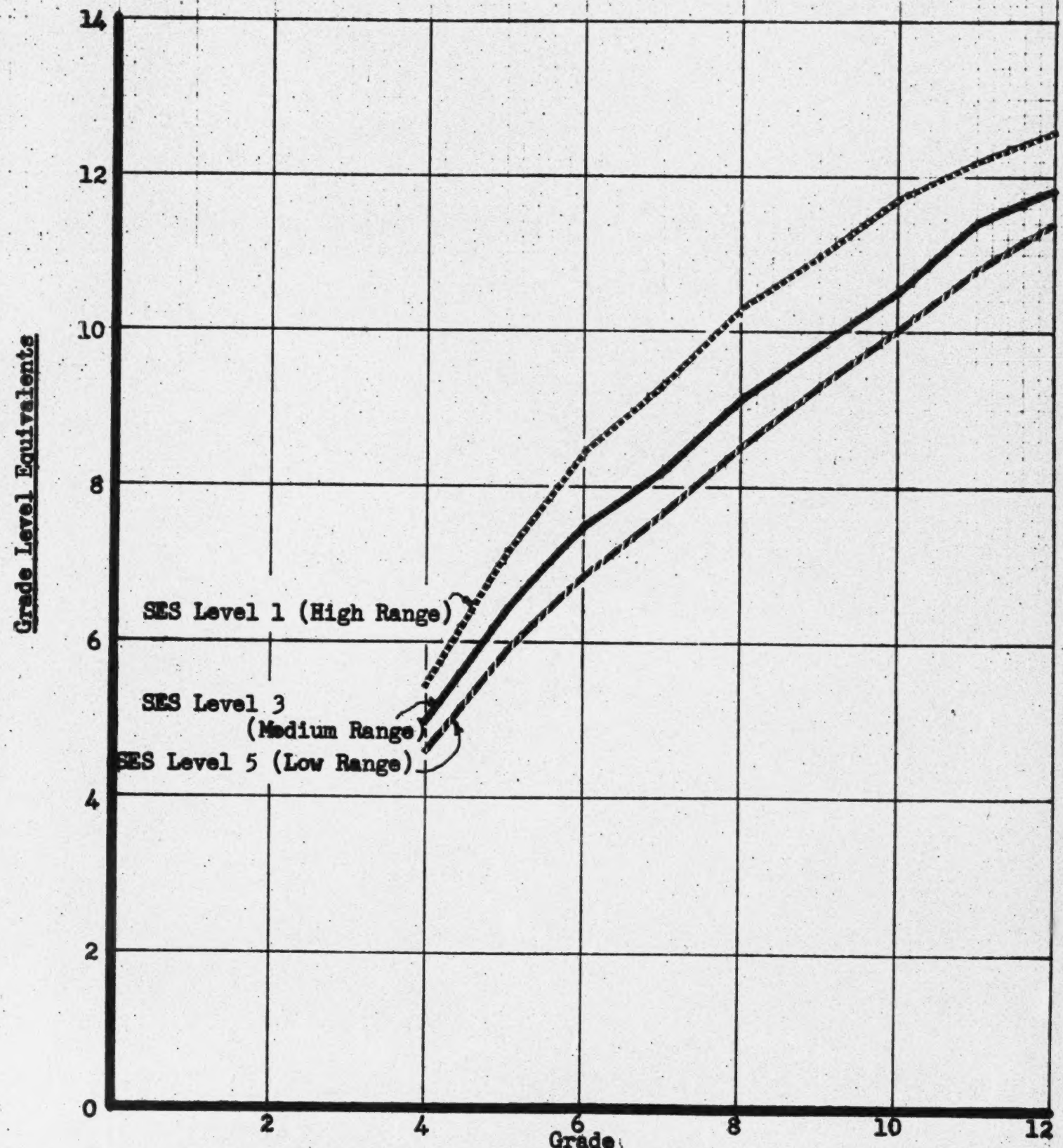
Vocabulary - Grade Level Equivalents for Total Sample
New York Students, By Size of Community



SOURCE: Quality Measurement Project, University of the State of New York. School Quality Workbook: Achievement Norms for New York State Schools by Type of Community and Socioeconomic Level. New York State Education Department, Division of Research: January 1963.

Figure 2

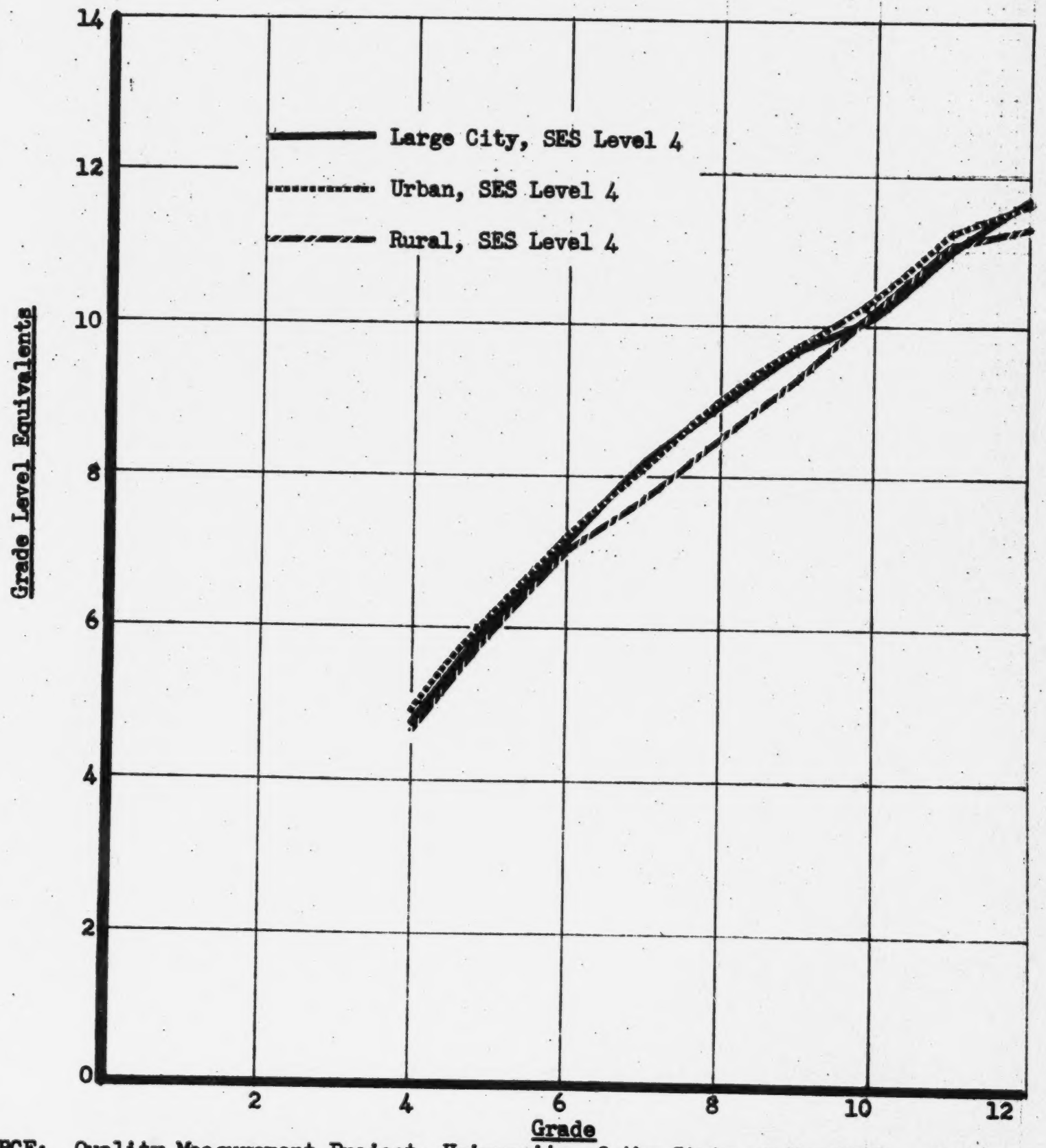
Vocabulary - Grade Level Equivalents for Total Sample New York Students, By Socioeconomic (SES) Level



SOURCE: Quality Measurement Project, University of the State of New York. School Quality Workbook: Achievement Norms for New York State Schools by Type of Community and Socioeconomic Level. New York State Education Department, Division of Research: January 1963.

Figure 3

Vocabulary - Grade Level Equivalents for Total Sample New York Students by Community Size - Socioeconomic (SES) Level



SOURCE: Quality Measurement Project, University of the State of New York. School Quality Workbook: Achievement Norms for New York State Schools by Type of Community and Socioeconomic Level. New York State Education Department, Division of Research: January 1963.

A Word of Caution

Statements describing increments of learning by single years of grade encounter a rather formidable problem when the unit of measurement of scores is considered. For example, when a student scores a "20" on one test at grade x and a "30" on the same (or interlocked) test at grade $x + 1$, what meaning can be attached to the increase of 10 test points?

The difficulty here is that the increase in achievement from 10 to 20 may or may not have the same "difficulty index" as the increase from 20 to 30 test points. In other words, the scale of measurement of test scores may or may not have been linear--at least there is no information concerning this.

Thus, it would be meaningless to say that an increase in test points from 20 to 30 is a 50% increase. A valid comparison, however, may be made whenever the same test (or test with equivalent scores) is given to two groups and the results compared in terms of the same unit of measurement. Here again, however, comparisons are restricted to an ordinal or ranking type of scale which is unique up to a monotonic transformation, i.e., an order-preserving transformation. Thus a score may be considered to be "greater than" or "less than" another score but never "twice" another score.

Conversion of Test Score Points to Grade Level Equivalents

In order to portray test score points more graphically and to convert them to a readily understandable scale, grade level equivalents

(GLE) have been charted from test score points. These begin with a common assumption: that the mean score received at a particular grade is the GLE for that grade. Thus, whenever equal scales are used on both vertical and horizontal axes, a 45° line results as the mean score line depicting conversion from grade to GLE.

GROWTH OF ACHIEVEMENT

Test Scores (Table 1 and Figures 4 - 6)

Test score profiles over the grades for all races and for all tests are remarkably similar in appearance, i.e., all races exhibit not only the same approximate rank position for each of the 3 tests and grades but the shape of the curves are very similar.

The White students are between 3 to 4 test points above the national means for all 3 tests and at all 3 grade levels. The Oriental-Americans approximate the national mean for 2 of the 3 tests and substantially exceed the national mean in the mathematics test for the 9th and the 12th grades.

The remaining minority groups are all substantially below the national mean; they exhibit, however, very similar characteristics over subject matter. For example, for all 3 tests, the Mexican-Americans are constantly between 8 to 10 test score points below the national mean for all grades. The American-Indian and Negroes show the characteristic decreasing learning rates although at much different absolute rates, i.e., the Negro curve has a much more rapid decline. The Puerto Ricans are the only group which exhibit an increasing rate of learning over the grades (in 2 out of 3 tests).

Among the minority groups (except Oriental-Americans), in terms of rank comparisons, the American-Indians show the least drop measured from the national means--followed very closely by the Mexican-Americans. The Negro test scores are higher than the Puerto Ricans or Mexicans in 2

TABLE 1. -Mean Test Scores for Reading, Verbal, and Mathematics, Grades 6, 9, and 12 by Race, SMSA-NonSMSA, and Region*

Race/Region	Reading			Verbal			Mathematics		
	6	9	12	6	9	12	6	9	12
Negro-SMSA									
NE	32.16	47.97	63.56	25.11	41.28	54.66	22.90	35.87	38.82
MW	32.04	49.16	64.25	24.92	42.71	54.48	22.61	37.29	41.23
SE	29.65	44.56	57.62	22.19	37.55	48.67	20.73	34.48	36.80
SW	29.67	43.72	56.41	23.14	37.70	48.05	20.86	34.80	36.34
W	30.06	44.21	58.41	23.58	40.04	50.87	20.69	34.24	38.24
Negro-NonSMSA									
SE	25.60	38.97	51.57	18.96	32.78	42.52	19.02	31.11	34.22
SW	27.83	42.60	54.16	22.13	35.92	45.51	20.79	33.67	37.18
N + W	29.28	47.16	57.94	22.87	39.33	49.09	21.57	36.25	38.90
White-SMSA									
NE	44.75	63.15	77.72	37.23	56.71	69.77	35.03	49.68	58.02
MW	44.13	62.59	76.36	36.43	56.69	67.86	34.57	49.77	57.71
SE	42.55	60.58	75.74	33.65	53.73	66.04	32.48	46.99	54.82
SW	42.12	59.01	75.74	33.61	52.90	66.63	31.24	46.12	56.28
W	43.10	59.85	73.70	35.16	54.72	67.73	33.45	48.00	55.81
White-NonSMSA									
SE	40.73	58.19	72.91	32.00	50.24	63.09	30.88	45.44	54.27
SW	43.69	61.47	75.35	35.02	53.83	66.46	32.98	48.01	55.89
N + W	43.61	61.10	75.16	35.89	54.35	65.97	33.83	48.98	55.90
Negro Total	29.46	44.71	57.94	22.59	38.31	49.04	21.02	34.53	37.47
White Total	43.28	61.15	75.58	35.27	54.61	66.94	33.41	48.36	56.45
Oriental-Americans	37.79	57.67	69.95	30.29	50.58	62.95	28.94	47.68	55.48
American Indians	30.55	48.86	61.69	24.47	42.89	53.44	22.71	37.76	45.19
Mexican-Americans	27.97	46.93	61.51	22.24	41.58	53.69	21.70	36.99	44.47
Puerto Ricans	22.88	42.36	58.74	17.53	38.02	52.50	17.87	32.58	41.00
Total Mean	38.97	57.02	72.09	31.44	50.65	63.55	29.83	44.96	52.98

*Coleman, J., et. al., op. cit.

Figure 4

Reading - Test Scores, By Grade, All Races

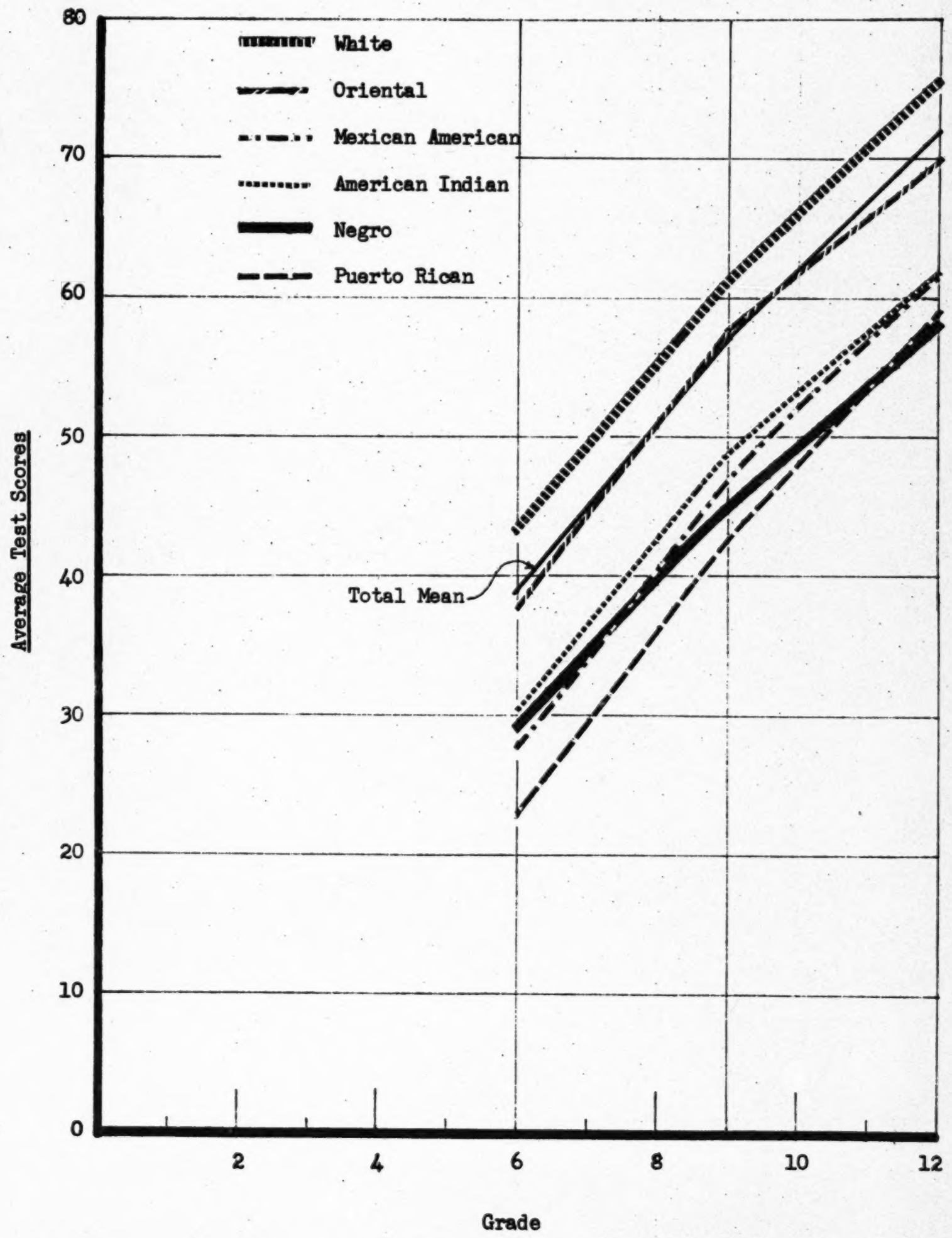


Figure 5

Verbal - Test Scores, By Grade, All Races

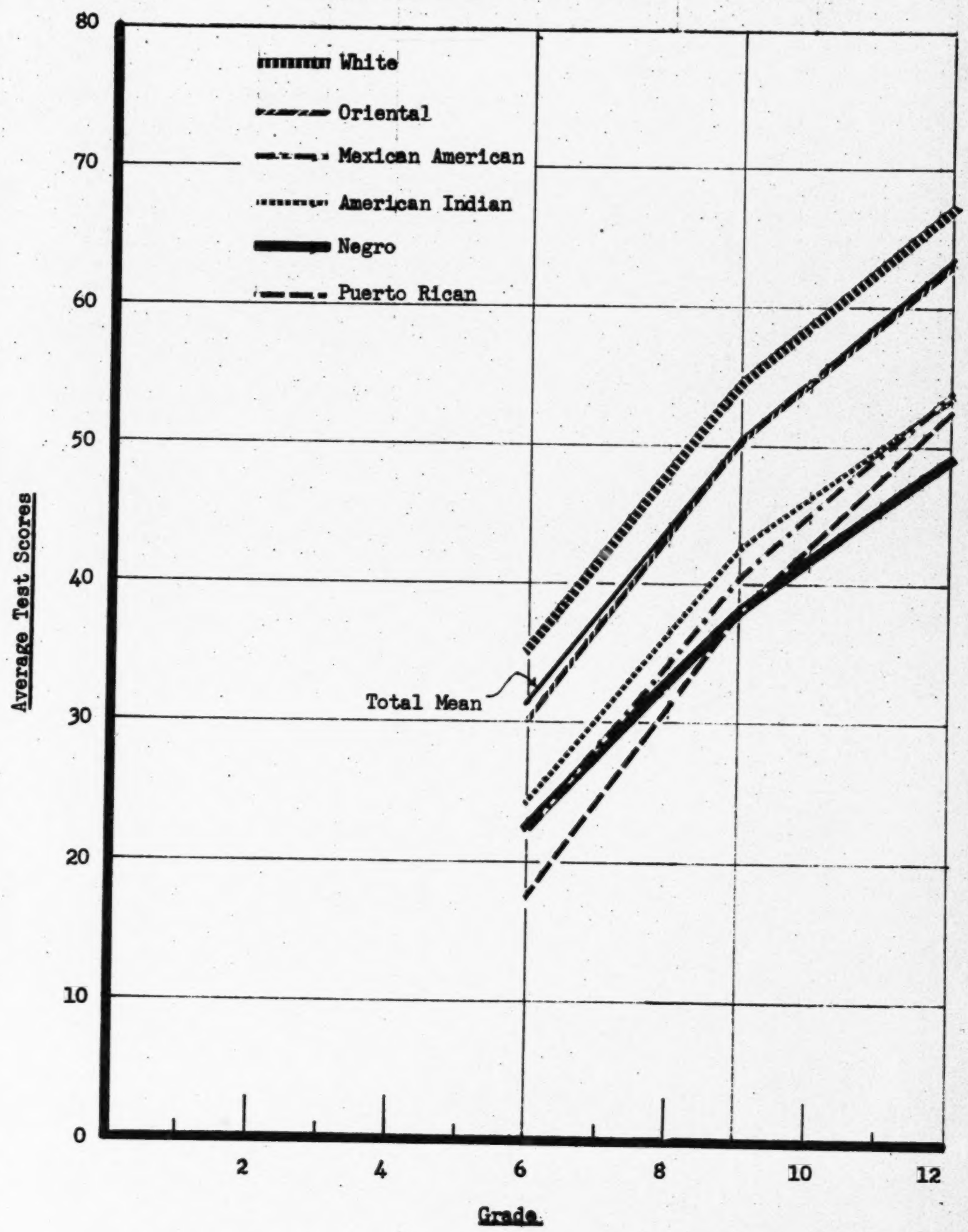
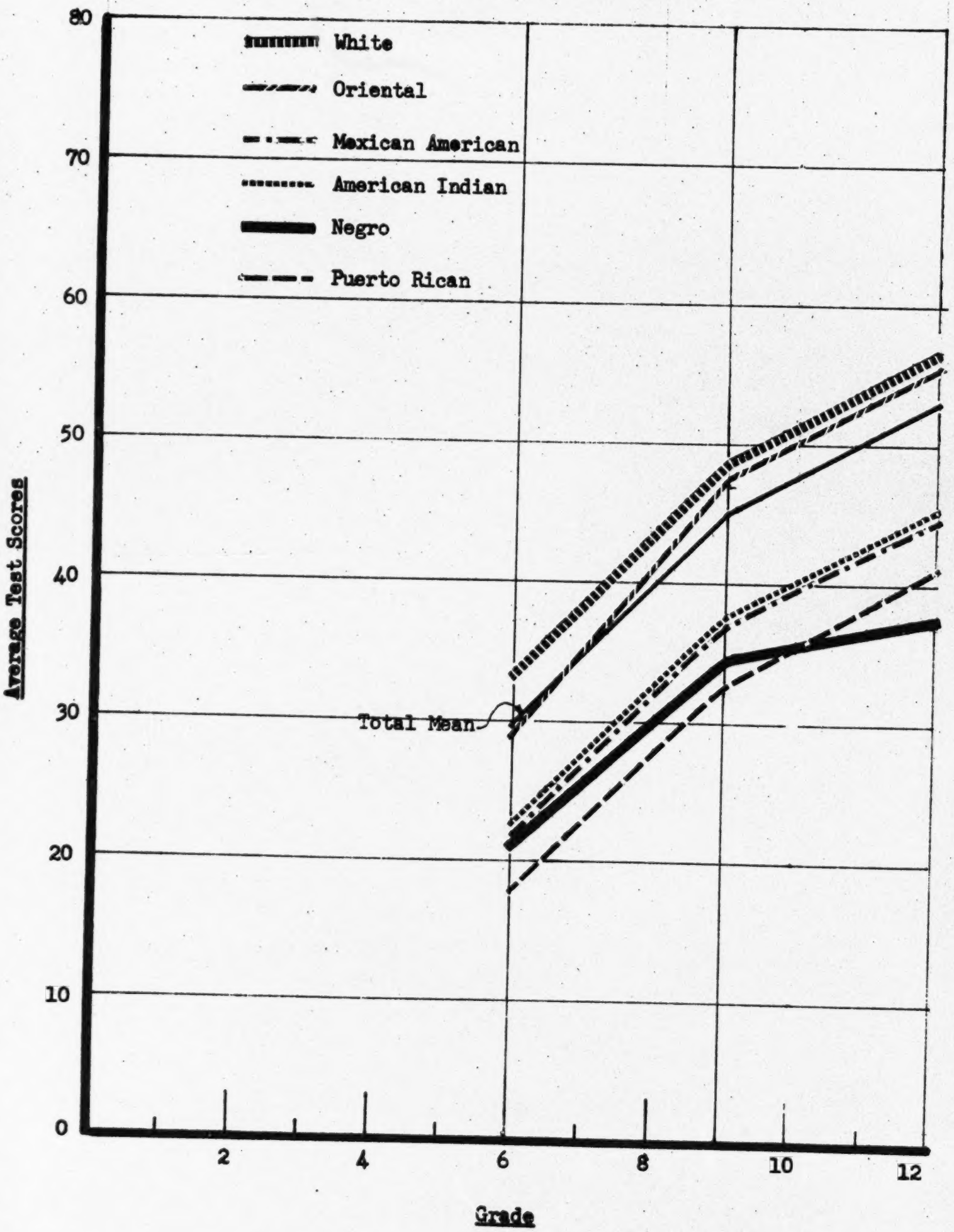


Figure 6

Mathematics - Test Scores, By Grade, All Races



out of 3 tests at the 6th grade level, but by the 12th grade, the Negroes are the lowest of the minority groups. It is believed that for some groups, especially the Negroes, test scores would actually be much lower than indicated, since by the 12th grade attrition (primarily in terms of drop-outs) eliminates many of the poorer students. Table 2 shows the magnitude of differences for each group in terms of test score points either above (+) or below (-) the national means. Possible trends over the years may be inferred for some groups.

TABLE 2.-Test Score Points Above (+) or Below (-) Total Mean Scores for Reading, Verbal, and Math Tests, All Races

	READING			VERBAL			MATHEMATICS		
GRADES	6	9	12	6	9	12	6	9	12
WHITE	+ 4.3	+ 4.1	+ 3.5	+ 3.8	+ 4.0	+ 3.4	+ 3.6	+ 3.4	+ 3.5
ORIENTAL-AMERICANS	- 1.2	+ 0.7	- 2.1	- 1.2	- 0.1	- 0.6	- 0.9	+ 2.7	+ 2.5
AMERICAN-INDIANS	- 8.4	- 8.2	-10.4	- 7.0	- 7.8	-10.1	- 7.1	- 7.2	- 7.8
MEXICAN-AMERICANS	-11.0	-10.1	-10.6	- 9.2	- 9.1	- 9.9	- 8.1	- 8.0	- 8.5
PUERTO RICANS	-16.1	-14.7	-13.4	-13.9	-12.6	-11.1	-12.0	-12.4	-12.0
NEGROES	- 9.5	-12.3	-14.2	- 8.9	-12.3	-14.5	- 8.8	-10.4	-18.5

Test Scores for White, Negro, and National Means (Figures 7-9)

As a general observation, differences between Negro and White test results increasingly widen over time. At the 6th grade level, the Negro scores are 2.3, 1.4, and 1.8 grade-level-equivalent years below the 6th grade norm for Reading, Verbal, and Mathematics, respectively. By the 12th grade, they are 2.8, 3.2 and 4.5 grade years, respectively, below the norm. When compared with White scores, the Negro 6th graders are 3.0, 2.0, and 0.5 grade years below, while at the 12th grade, the Negro scores are 3.4, 3.8, and 5.5 grade years, respectively, below the White Reading, Verbal, and Mathematics scores, respectively.

From the standpoint of subject matter, Mathematics shows the greatest decline in learning rates for both Whites and Negroes.* It may be noted that at the 9th grade level, there is a much more abrupt decline in Negro grade level equivalent scores than the White grade level equivalent. The verbal test results typify the decremental learning rate curves while the Reading test results are almost linear from grades 6 through 12.

*This may perhaps be due to the nature of the subject matter which places so much importance on the ability to master lower level material before the next higher one may be learned.

Figure 7

Reading - Grade Level Equivalents, By Grade, All Races

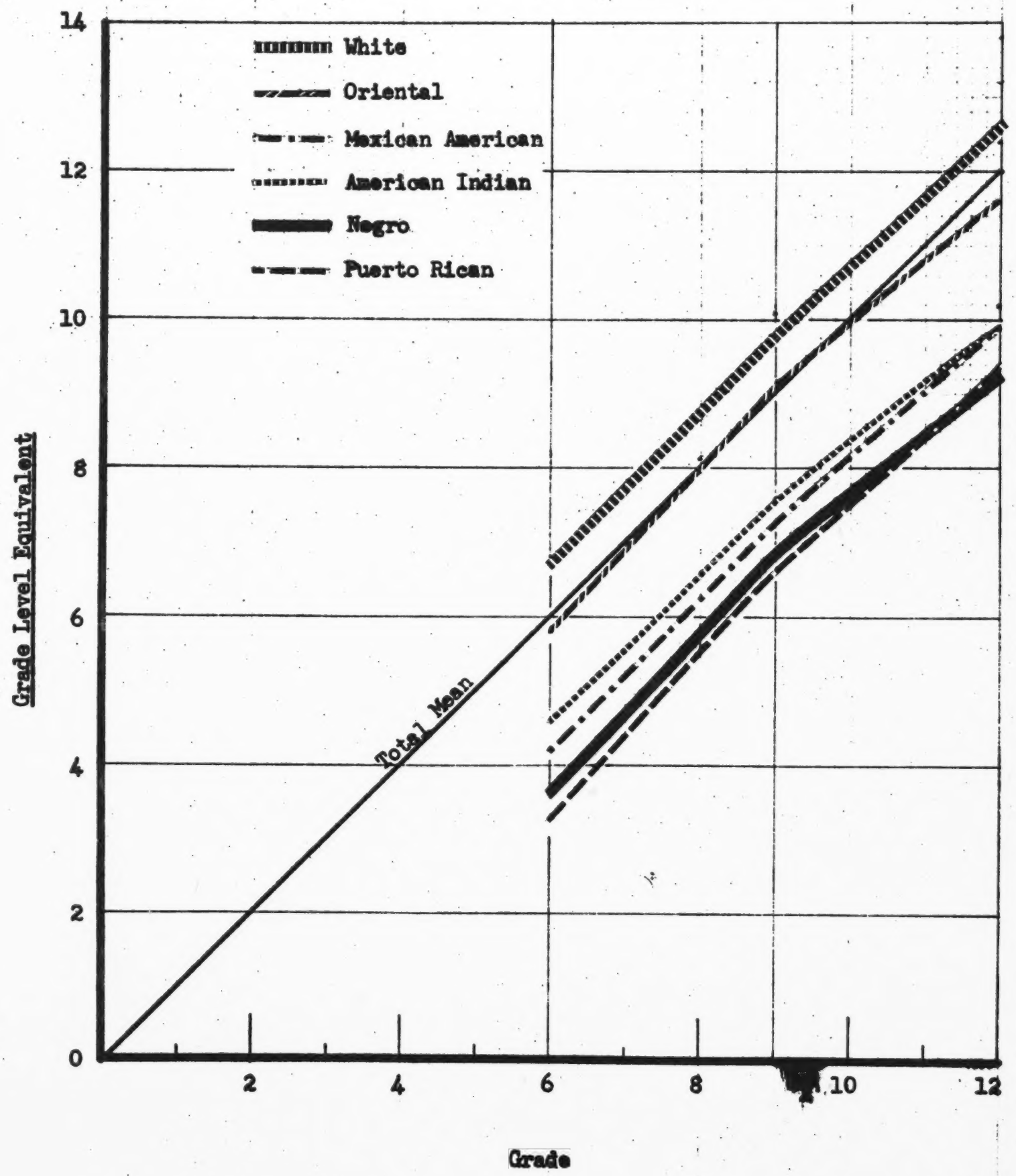


Figure 8

Verbal - Grade Level Equivalents, By Grade, All Races

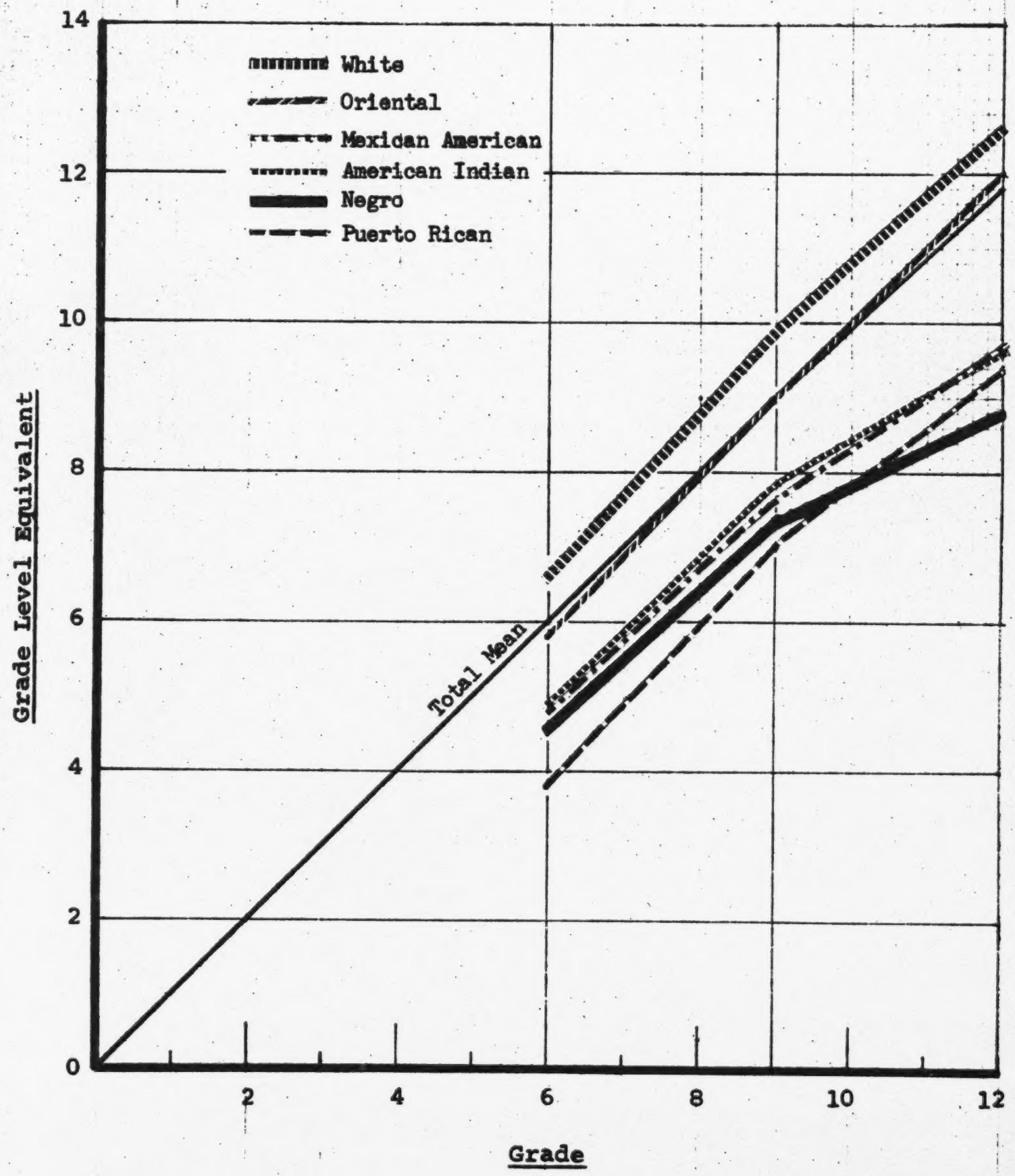
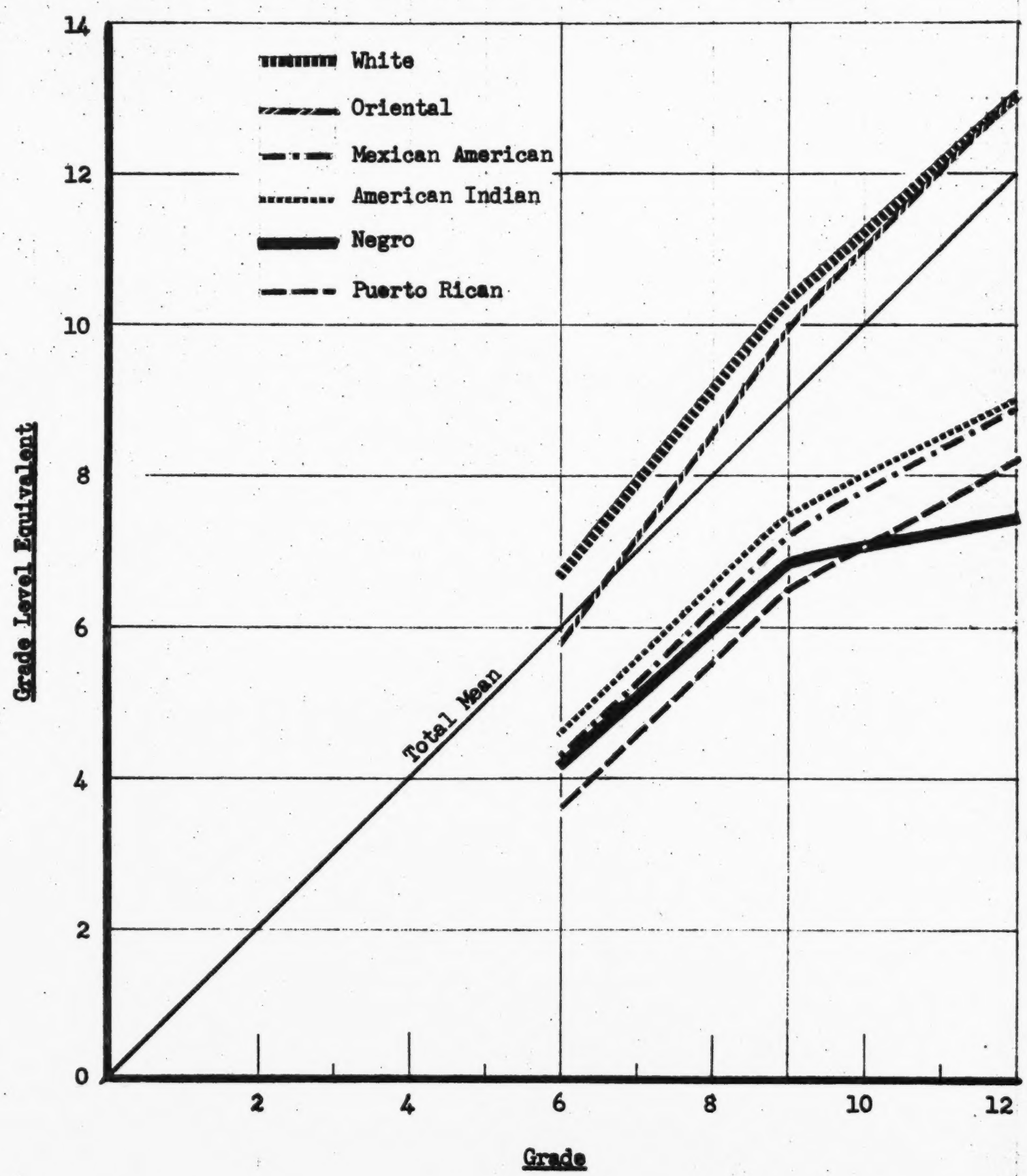


Figure 9

Mathematics - Grade Level Equivalents, By Grade, All Races



Grade Level Equivalent Comparisons

In terms of grade level equivalents, Figures 10-15 reflect the preceding results. For minority groups other than Oriental-Americans, mathematics show the greatest decline in learning rate over the years. Also, for these groups the verbal test results begin at a higher grade level equivalent than reading at grade 6, but by the 12th grade, the reverse is true.

Table 3 shows the magnitude of differences for each group in terms of grade level equivalents for grades 6 through 12 for the three tests. As may be noted, none of the minority group members attain a GLE of 5.0 years at the 6th grade level and none achieve a GLE of 10.0 years at the 12th grade. The deficiency (from the national mean) of grade level years range from 1.1 - 2.7 years at the 6th grade to 2.1 - 4.5 years at the 12th grade. If White mean scores are compared with minority group scores, the difference becomes even larger: at the 6th grade, it ranges from 1.7 - 3.4 years and at the 12th grade from 2.9 - 5.5 years.

In making direct grade level comparisons the following qualifications should be noted: the characteristics of distributions of obtained scores for any group depends upon arbitrary practices in instruction and curriculum organization. Socio-economic status, community differences, etc., are also of great importance in evaluating grade-by-grade comparisons. Further, with each advancing chronological age level there is an increase in the maturation level such that identical scores on a test for 2 different grade levels fails to indicate differences in living experience for the two groups, which may in fact impart a different meaning for identical test score points.

Figure 10

Reading - Test Scores For White, Negro and National Means
By Grade

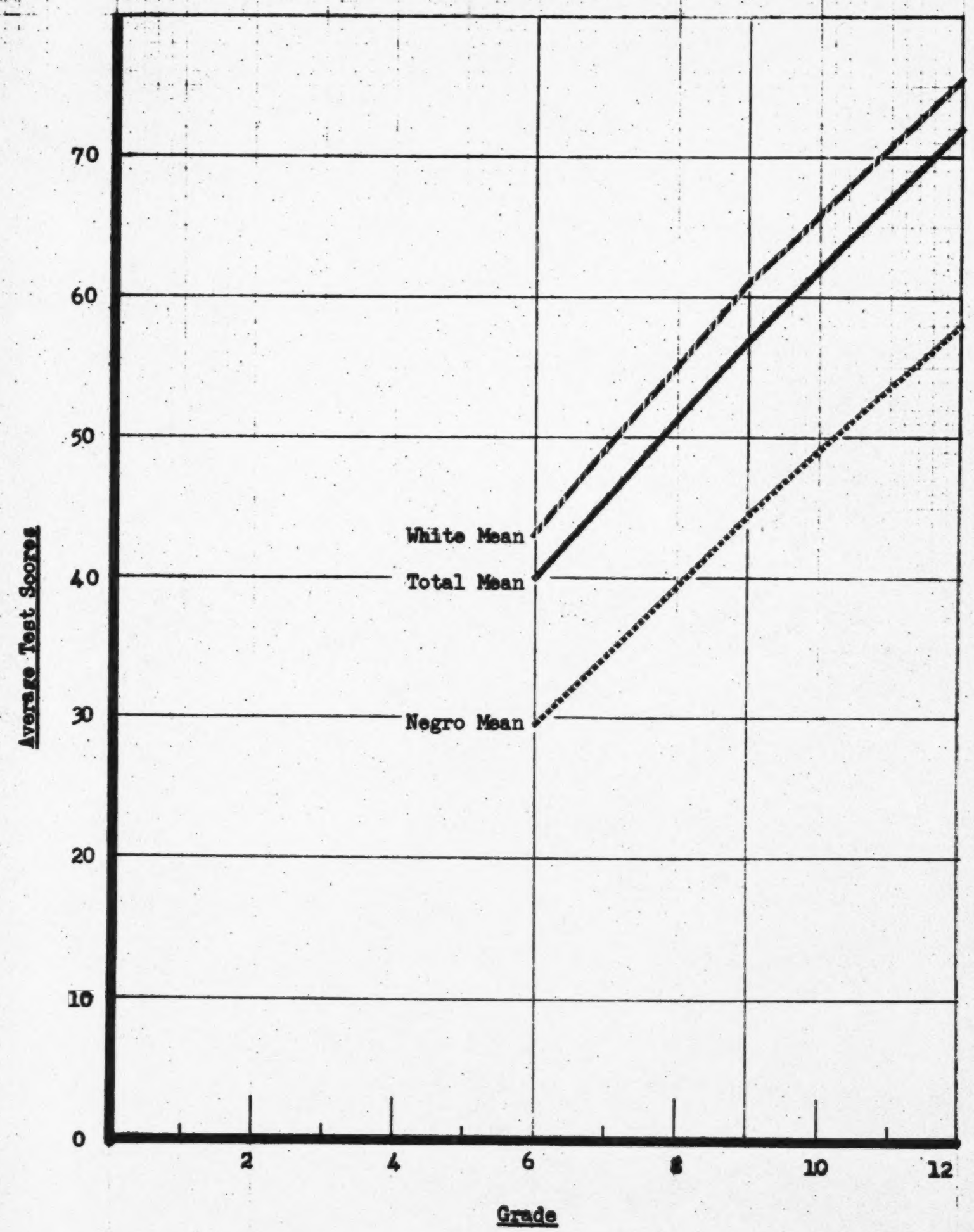


Figure 11

Verbal -- Test Scores For White, Negro and National Means
By Grade

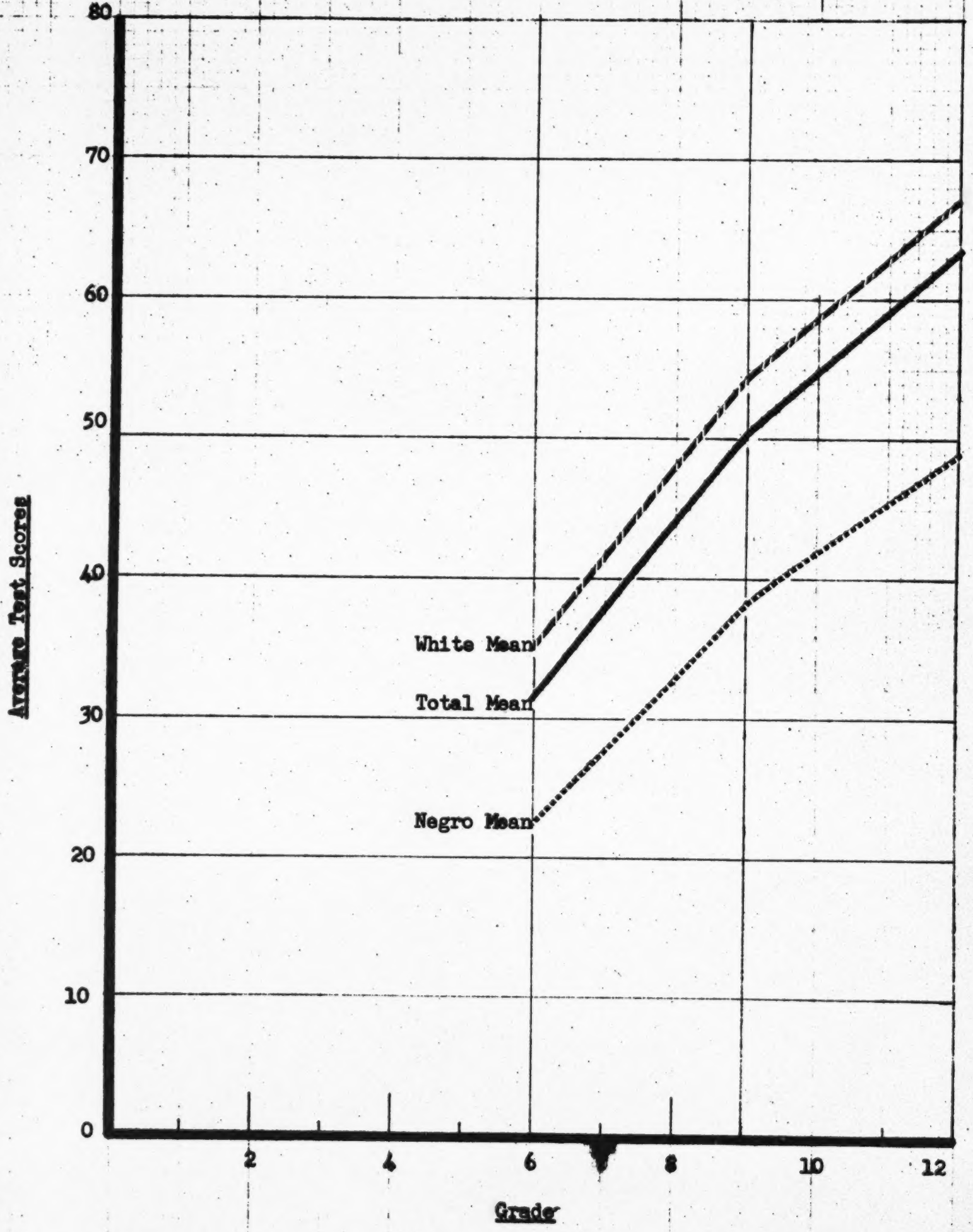


Figure 12

Mathematics - Test Scores, For White, Negro and National Means
By Grade

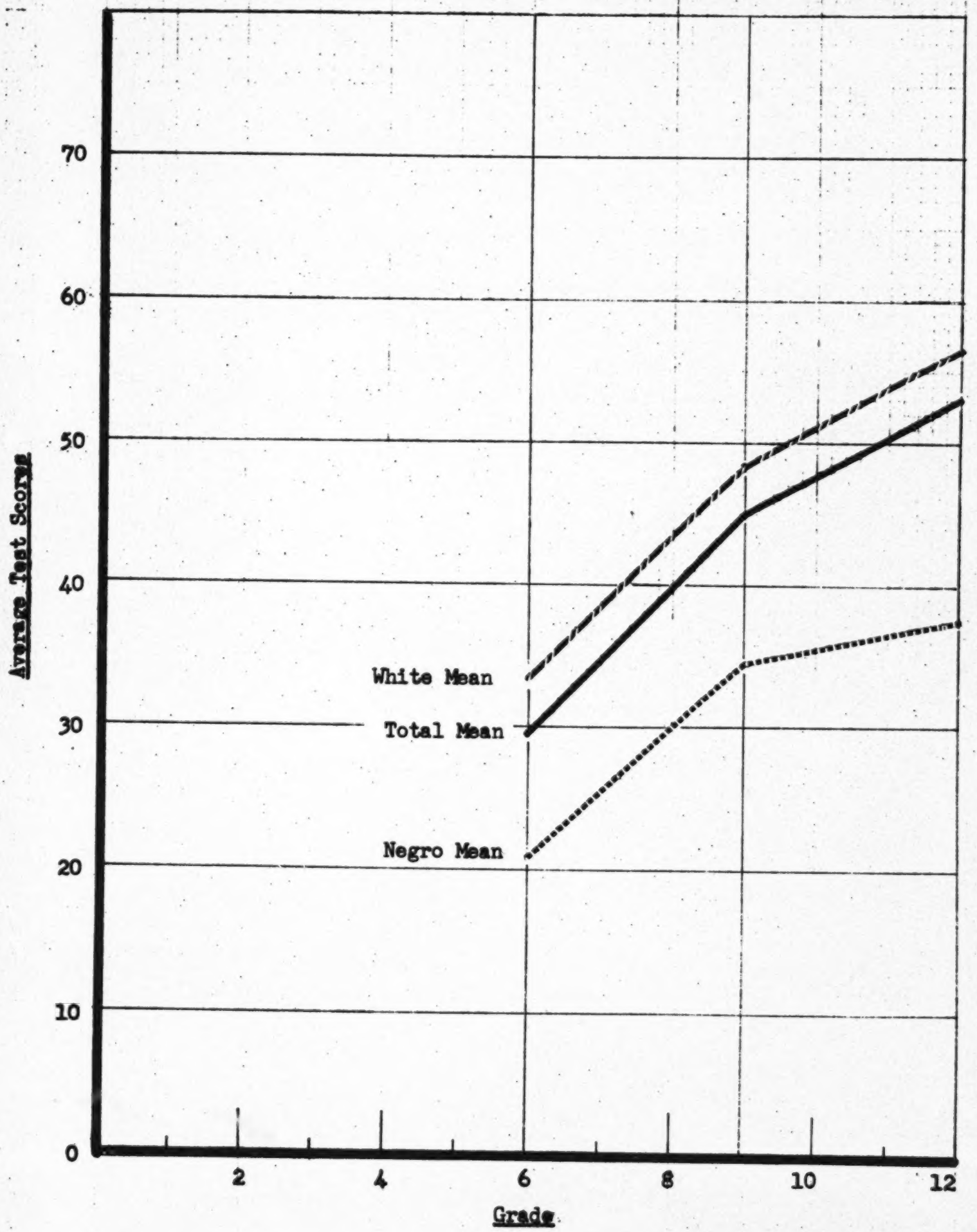


Figure 13

Reading - Grade Level Equivalents For White, Negro and National Means By Grade

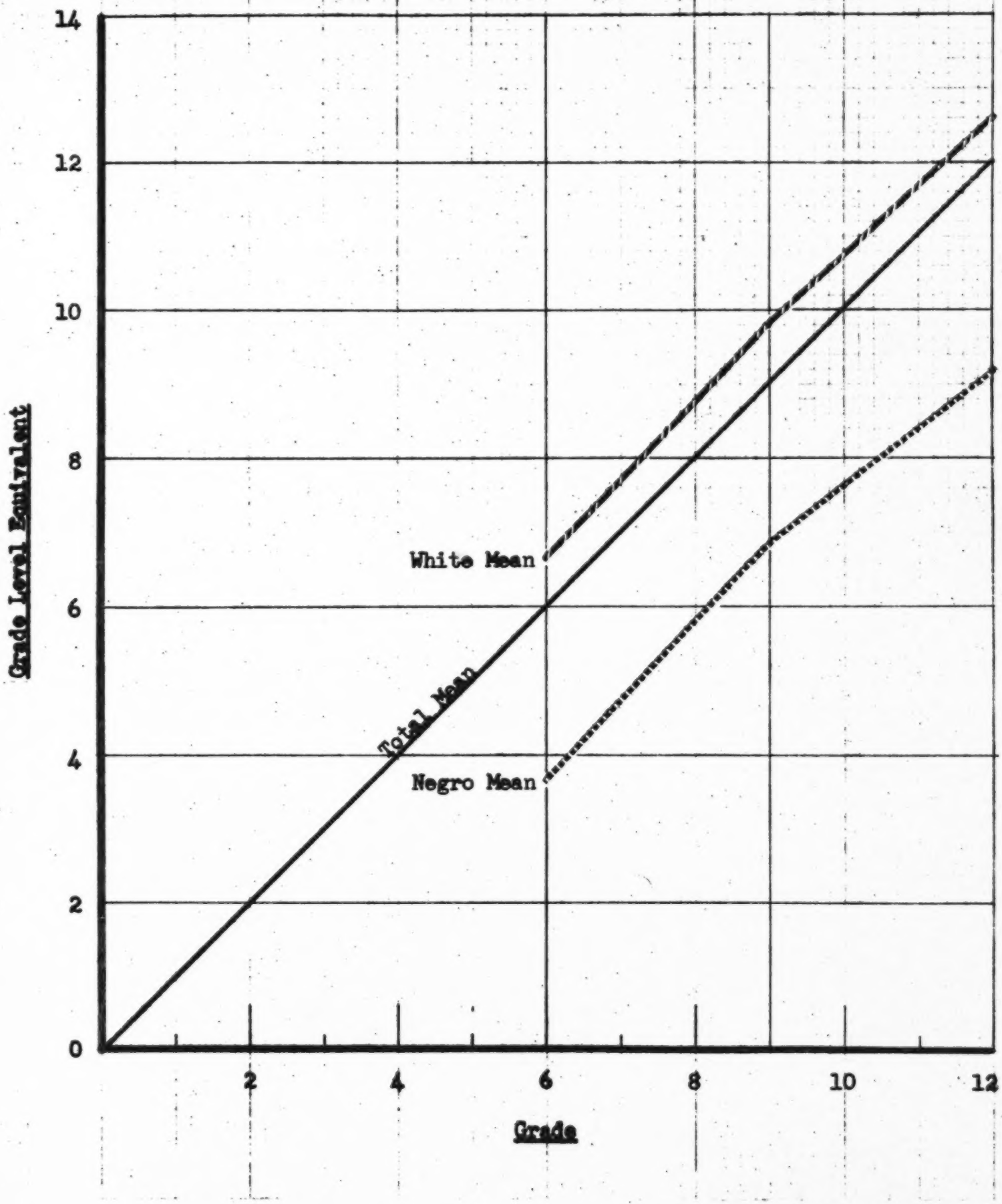


Figure 14

Verbal - Grade Level Equivalents For White, Negro and National Means By Grade

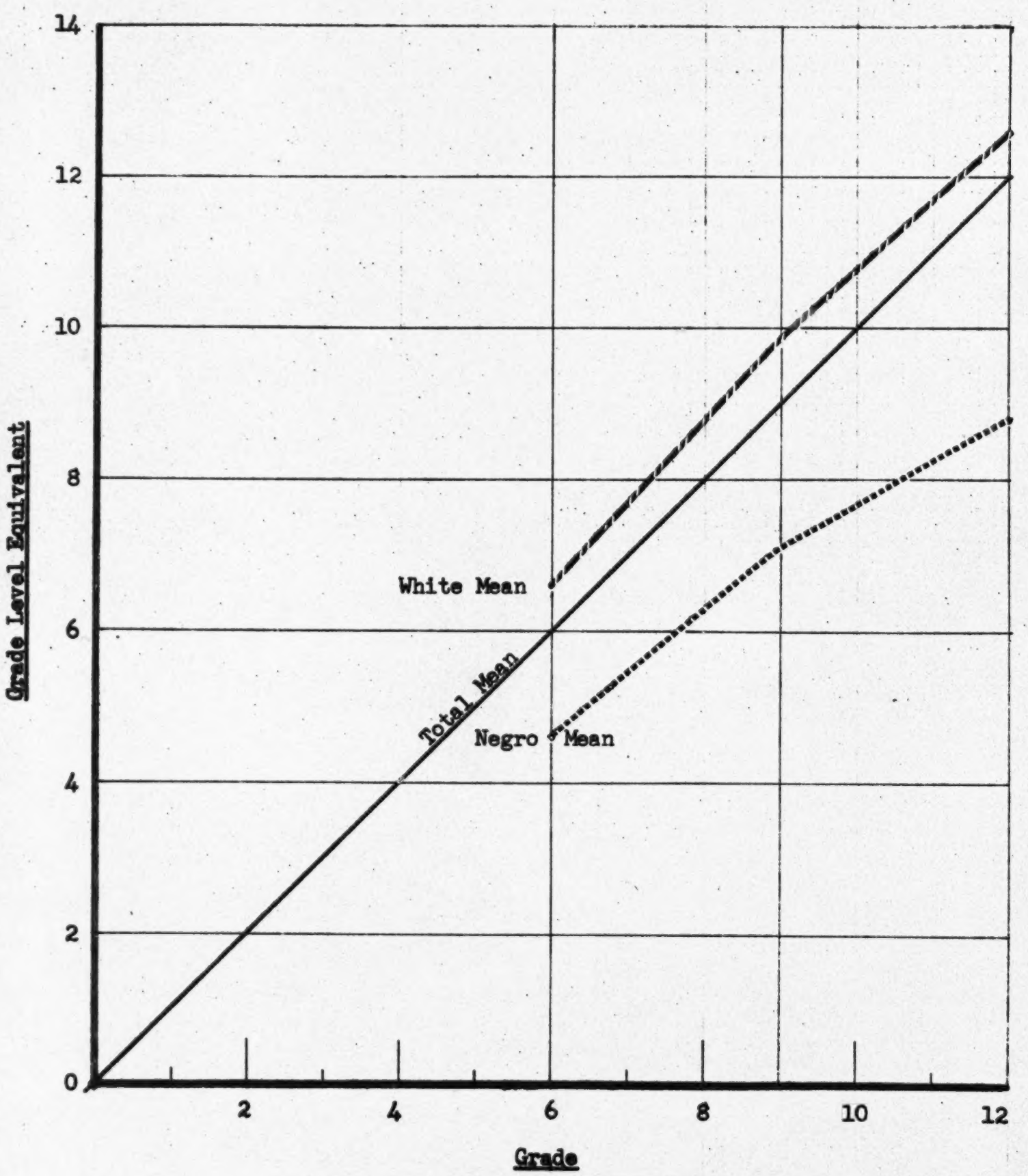


Figure 15

Mathematics - Grade Level Equivalents for White, Negro and National Means By Grade

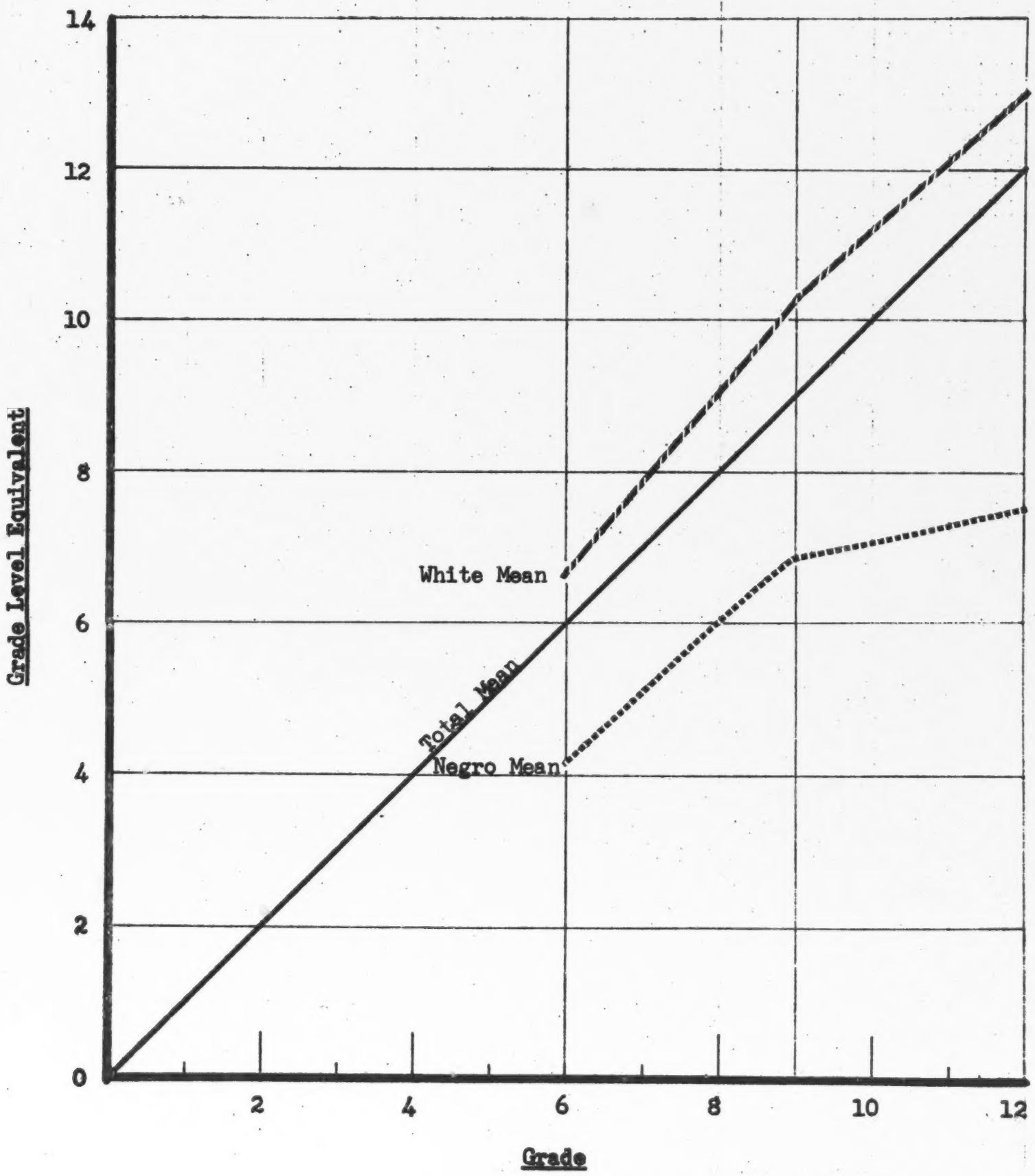


TABLE 3.-Grade Level Equivalents Derived From National Means For Reading, Verbal and Mathematics Test Scores, by Grade and Race*

READING

GRADE:	6	7	8	9	10	11	12
NATIONAL	6.0	7.0	8.0	9.0	10.0	11.0	12.0
WHITE	6.7	7.7	8.7	9.8	10.8	11.7	12.6
ORIENTAL-AMERICAN	5.8	6.9	8.0	9.1	9.9	10.7	11.6
AMERICAN-INDIAN	4.6	5.6	6.6	7.6	8.3	9.0	9.9
MEXICAN-AMERICAN	4.2	5.5	6.3	7.3	8.1	8.9	9.9
PUERTO RICAN	3.3	4.4	5.5	6.6	7.5	8.4	9.3
NEGRO	3.7	5.3	6.1	6.9	7.7	8.4	9.2

VERBAL — Grade Level Equivalents

GRADE:	6	7	8	9	10	11	12
NATIONAL	6.0	7.0	8.0	9.0	10.0	11.0	12.0
WHITE	6.6	7.6	8.6	9.9	10.8	11.7	12.6
ORIENTAL-AMERICAN	5.8	6.9	7.9	9.0	9.9	10.9	11.8
AMERICAN-INDIAN	4.9	5.9	6.8	7.8	8.3	8.9	9.6
MEXICAN-AMERICAN	4.8	5.6	6.6	7.6	8.2	8.8	9.7
PUERTO RICAN	3.8	4.9	5.9	7.0	7.8	8.5	9.4
NEGRO	4.6	5.4	6.2	7.1	7.6	8.2	8.8

MATHEMATICS

GRADE:	6	7	8	9	10	11	12
NATIONAL	6.0	7.0	8.0	9.0	10.0	11.0	12.0
WHITE	6.7	7.7	8.7	10.3	11.3	12.3	13.0
ORIENTAL-AMERICAN	5.8	7.1	8.3	10.0	11.0	12.0	13.0
AMERICAN-INDIAN	4.6	5.5	6.5	7.5	8.1	8.5	9.0
MEXICAN-AMERICAN	4.3	5.4	6.4	7.4	7.9	8.4	8.9
PUERTO RICAN	3.6	4.6	5.6	6.5	7.1	7.7	8.2
NEGRO	4.2	5.1	6.0	6.9	7.1	7.3	7.5

*All Grade Level Equivalents below 6.0 and above 12.0 have been extrapolated.

CONCLUSION

When comparisons of test score results or grade level equivalents are made in terms of racial and ethnic groups, very consistent results emerge: (1) the relative rankings of each group are generally preserved over both subject matter and grade, and (2) differences among racial and ethnic groups which are present at grade 6 in almost all cases widen by grade 12, with the Negro group showing a pronounced lowering in rate of achievement.

Negro-White differences in terms of grade level equivalents for Total Negro and Total White are as follows: for Reading, the Negro grade level equivalents lag 3.0, 2.9, and 3.4 years below the White students at grades 6, 9, and 12, respectively. In Verbal ability the Negro lag is 2.0, 2.8, and 3.8 years while for Mathematics 2.5, 3.4, and 5.5 years.

As may be noted, when comparisons are made of the number of lag-years between grade 6 and grade 12, the increasing manner in which the Negro students fall behind the White students is emphasized. In Reading, while essentially maintaining a 3 year lag at grades 6 and 9, by the 12th grade the lag becomes 3.4 years, or an increase of 13%. For Verbal ability the difference between White and Negro grade level equivalents almost double (from 2.0 years to 3.8 years) between grades 6 and 12. For Mathematics, this increasing lag is substantially more than double (from 2.5 years to 5.5 years).